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# STANDARDS LABORATORY

Installation and Operation Instructions

Model 262 Input Scanner

Neff Linear Systems Inc.

MODEL 262

STANDARDS LABORATORY

Document
No. 338

# Installation and Operation Instructions
# Input Scanner

## Model 262

Non-Linear Systems, Inc.
Del Mar Airport
Del Mar, California.

May, , 1960.

## INTRODUCTION

NLS Input Scanners are essentially "automatic" selector switches. Used in conjunction with NLS Digital Voltmeters and Data Recorders, they sequentially connect up to 100 or 200 input signals to the Digital Voltmeter, depending on the model. Model 260 has a capacity of 100 inputs, single pole; Model 261, 200 inputs, single pole; Model 262, 100 inputs, double pole.

## INSTALLATION

The Model 262 Input Scanner may be installed in a standard 19" rack cabinet after removing the rubber feet, or it may be operated on the bench.

Caution:

The unit contains a mercury wetted contact relay; therefore after installation has been completed, the Scanner chassis must be within 30° of horizontal.

Connect the cables provided from the Digital Voltmeter to the Scanner, from the Scanner to the Data Recorder, and from the Data Recorder to the Digital Voltmeter. (The latter two may be one cable depending on the printer type). Connect the power cord to a source of 115V, 50-400 cps. (Unless different voltage has been specified.)

Input connections to the 104-Pin connectors are shown on page 3.

## OPERATION

1. Turn the power switch on; the readout will illuminate.

   Set the Digital Voltmeter to the "CONTINUOUS PRINT" mode as described in the appropriate handbook.

   Set the Printer, Typewriter, or other Data Recorder to the recording mode as described in the appropriate handbook.

2. On the Scanner panel, set the "RESET" selector switches to the number which represents the input to be measured first.

3. Set the "STOP" selector switches to the number which represents the input to be measured last.

4. Push the "RESET" button; the Scanner will switch to the number to which the "RESET" selectors are set.

5. To measure each of the selected inputs once only, set the power switch to "ONE CYCLE". To scan the selected inputs repeatedly, set the switch to "AUTO CYCLE".

## OPERATION

6. Push the "START" button. The Digital Voltmeter will measure the first input, the Printer will record the resulting reading, and the Scanner will switch to the next input, repeating the measure-record-print cycle. Since the Scanner triggers the Digital Voltmeter, the Digital Voltmeter triggers the Printer, and the Printer triggers the Scanner, the overall time per reading is dependent upon the type of Digital Voltmeter and Printer.

   When the Scanner reaches the number to which the "STOP" selectors have been set, if the power switch is in the "ONE CYCLE" position, the system stops operation after printing the last reading. If the power switch is in the "AUTO CYCLE" position, the Scanner automatically resets to the number to which the "RESET" selector switches have been set, and the cycle repeats.

7. System operation may be stopped by pushing the "STOP" button.

## INPUT AND OUTPUT SIGNAL CONNECTIONS

Input connections to the 104-pin connectors are shown in the table below. Cable connector type is Winchester XMRA104S-C-2A-706.

| Input Number (1st 50) | Input Number (2nd 50) | Pins | Input Number (1st 50) | Input Number (2nd 50) | Pins |
|---|---|---|---|---|---|
| 00 | 50 | A and B | 27 | 77 | AL and AM |
| 1 | 51 | C D | 28 | 78 | AN AP |
| 2 | 52 | E F | 29 | 79 | AR AS |
| 3 | 53 | H J | 30 | 80 | AT AU |
| 4 | 54 | K L | 31 | 81 | AV AW |
| 5 | 55 | M N | 32 | 82 | AX AY |
| 6 | 56 | P R | 33 | 83 | AZ BA |
| 7 | 57 | S T | 34 | 84 | BB BC |
| 8 | 58 | U V | 35 | 85 | BD BE |
| 9 | 59 | W X | 36 | 86 | BF BH |
| 10 | 60 | Y Z | 37 | 87 | BJ BK |
| 11 | 61 | a b | 38 | 88 | BL BM |
| 12 | 62 | c d | 39 | 89 | BN BP |
| 13 | 63 | f g | 40 | 90 | BR BS |
| 14 | 64 | h i | 41 | 91 | BT BU |
| 15 | 65 | j k | 42 | 92 | BV BW |
| 16 | 66 | m n | 43 | 93 | BX BY |
| 17 | 67 | p q | 44 | 94 | BZ CA |
| 18 | 68 | r s | 45 | 95 | CB CC |
| 19 | 69 | t u | 46 | 96 | CD CE |
| 20 | 70 | v w | 47 | 97 | CF CH |
| 21 | 71 | x y | 48 | 98 | CJ CK |
| 22 | 72 | z AA | 49 | 99 | CL CM |
| 23 | 73 | AB AC | | | |
| 24 | 74 | AD AE | SIGNAL GROUND: CR | | |
| 25 | 75 | AF AH | | | |
| 26 | 76 | AJ AK | SHIELD GROUND: CS | | |

Output connections ar as follows. Cable connector type is MS3106B-14S-6P.

| Pin | Function |
|---|---|
| A | Shield ground |
| B | Output A - First column of above input pin connections |
| C | Output B - Second column of above input pin connections. |
| D | Signal Ground - Inputs 00-49 (pin CR of above connector) |
| E | Signal Ground - Inputs 50-99 (pin CR of above connector) |

CONNECTIONS TO EXTERNAL CIRCUITS

A. Signal circuits - See page 3.

B. Printer receptacle - See Figure 1.

Momentary transfer of the contacts connected to pins CC, BB, and r causes the Scanner to advance to the next input number at the completion of the momentary transfer. Duration of the contact transfer is not critical but should be a minimum of 10 milliseconds.

The contacts connected to pins DD, FF, and HH in the scanner are transferred for approximately 20 milliseconds when the scanner switches to the next input number. These may be connected to initiate operation of the measuring instrument.

Momentarily actuated switches or relays may be connected as shown to provide remote control of the stop, start, and reset functions. These switches are connected in parallel with the corresponding switches on the front panel.

When the Scanner reaches the position to which the "STOP" selector switches are set, -12 volts (in series with 2700 ohms) appears on pin m. A sensitive relay (or suitable transistor circuit) may be connected between pins m and k for external indication of end of cycle.

Decade switching is as shown, isolated from all other Scanner circuits for connection to any Printer, Typewriter, or Tape or Card Punch.

C. Accessory receptacle - See Figure 2.

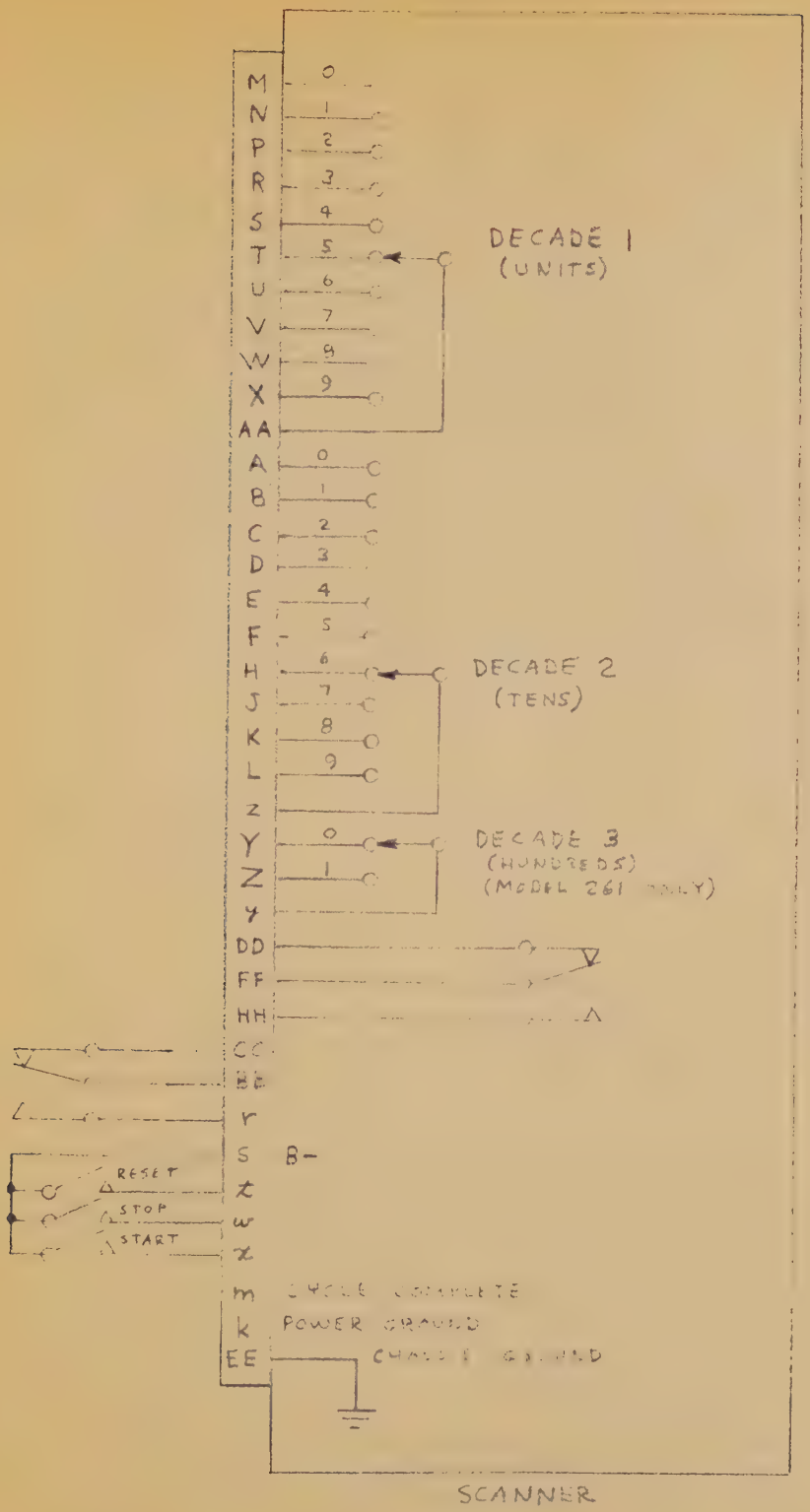
This receptacle, available on special order, may be used to operate a remote readout, relays for programming Digital Voltmeter function and ranging, or other external devices.

Decade switch outputs are -12VDC, and are connected in parallel with the readout lamps in the Scanner. External loads should not exceed 250 milliamperes non-inductive. Pin Z may be used for the "INPUT" lamp of a Model 260 or 262 remote readout, or for other purposes not exceeding 500 milliamperes. Common return is pin DD.

Pin CC, normally at -12VDC, is at approximately zero volts during resetting. A sensitive relay (or suitable transistor circuit) of 5000 ohms minimum resistance may be connected between pin CC and pin Z for interlocking external circuitry to prevent improper operation during resetting, when the readout lamps may be energized in random order.

Pins Y, LL, MM, and NN are connected in parallel with pins m, t, w, and x respectively of the printer receptacle described in B above, so that these functions are available on either connector.

# PRINTER RECEPTACLE WIRING




CABLE CONNECTOR TYPE IS WINCHESTER MRE 50S-JTC-H-6.

FIGURE 1
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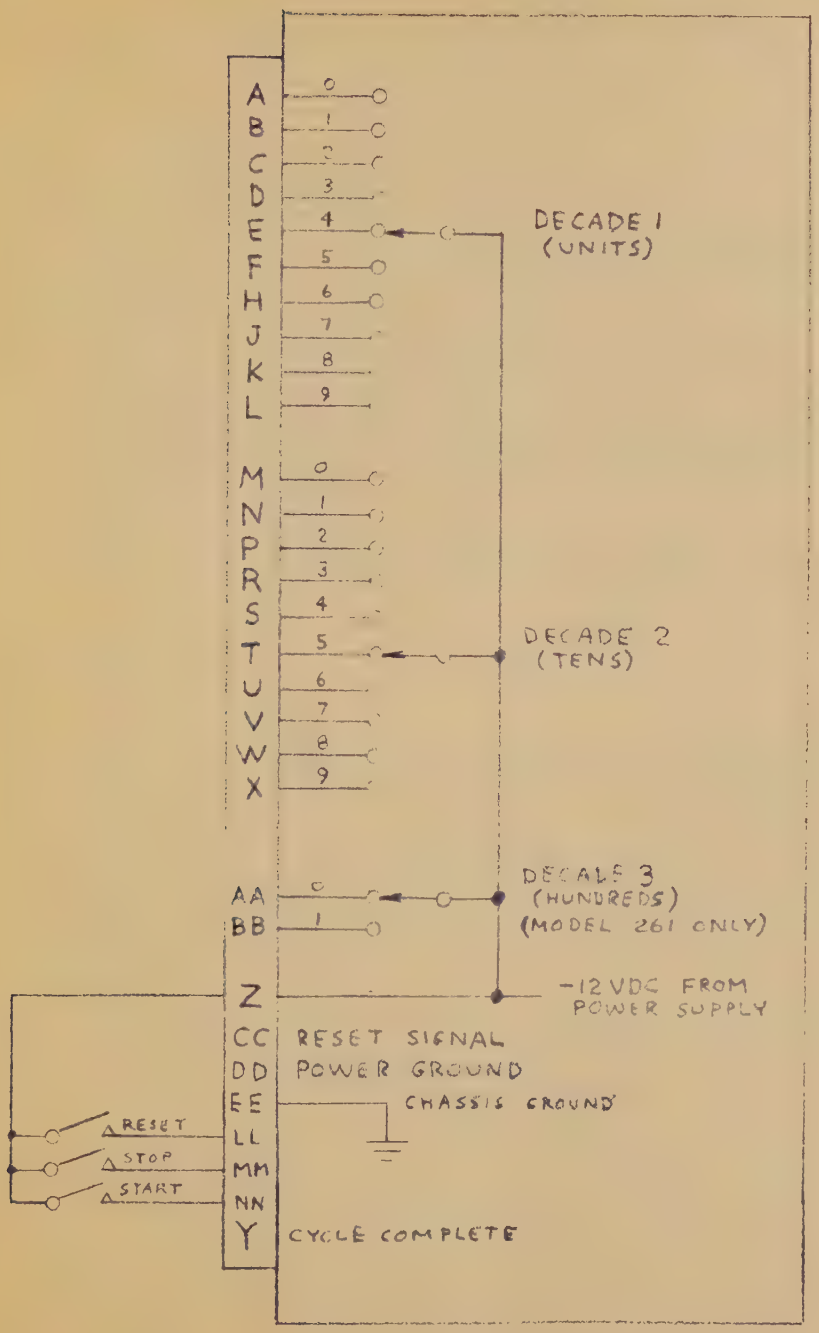
# ACCESSORY CONNECTOR WIRING




CABLE CONNECTOR TYPE IS WINCHESTER MRE34P-JTC-H-6.

FIGURE 2

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REVISED 4-6-60

MODIFICATION OF OLDER NLS DIGITAL VOLTMETERS:

To achieve proper operation with the Model 260, 261 and 262 Input Scanners, certain digital voltmeters must be modified as indicated below.

MODEL V24 and MODEL M24: Serial numbers prior to 10.542 except 10.345, 10.403, 10.384, 10.429, and 10.479:

In the B unit, change R30 and R34 from 1 megohm to 330K ohm. These are located at the front and rear of the main power supply board. Caution - do not change R32 (the 1 megohm resistor in parallel with the 1 mfd capacitor.)

This change has been accomplished at the factory in Serial Number 10.542 and subsequent.

MODEL V34 and V35:

Effective on all units:

A 27K resistor must be added in series with the normally open side of the external start scan contacts. This can be easily accomplished as follows:

On the bottom of the main etched circuit board, move the white/orange/blue wire from terminal 2 of J105 (the third plug-in board connector from the rear) to terminal 6 of J105, which is an unused terminal on the front "D" board. Add a 27K, 1/2 Watt resistor from terminal 2 to terminal 6.

This change is accomplished at the factory in models V34A and V35A - no modification is necessary.

CIRCUIT DESCRIPTION

1. Stepping Switch Circuitry. (See Drawings 21028-020 Sheet 2A and 2B)

A. The input signal leads are connected in pairs to stepping switches K102 and K103. Inputs 00 to 19 are connected to K102, levels C and D, inputs 20 to 39 are connected to K102 levels E and F, etc. Similarly, inputs 60 to 99 are connected to K103.

The wipers of levels C through H of K102 and levels E thru H of K103 are connected to levels E and F of K101. The output signal leads are connected to the wipers of level E and F of K101. All of the above signal wiring is twisted in pairs and shielded where practical to minimize noise pickup in low level circuits such as thermocouples.

The position of K101 corresponds to the tens digit of the selected input number, and the position of K102 or K103 corresponds to the units digit. As an example, if K101 is in position 6 and K103 is in position 7, input pair 67 is connected to the output connector.

B. Wipers of levels A and B of K101 are connected to -12VDC. Positions 0 through 9 of level A are connected to the middle window of the readout, to indicate the tens digit of the input number.

Positions 0 thru 19 of level A of K102 (via isolating diodes CR110 thru CR129,) and positions 0 through 9 of the B level and positions 10 thru 19 of the A level of K103 are connected to the righthand window of the readout, to indicate the units digit of the input number.

Level B of K101 selects the A or B level of the stepping switch corresponding to the tens digit. As an example, if the input number is 37, position 3 of level B, K101 energizes the wiper of the A level of K102. Position 17 of the A level of K102 energizes the 7 lamp of the units readout via blocking diode CR127, so that the readout reads 37.

C. The wiper and positions 0 thru 9 of level D of K101 are connected to recepacle J101 for printing the tens digit of the input number. Positions 0 thru 19 of level B of K102, and of level C of K103. are similarly connected. Level C of K101 selects the B or C level of the stepping switch corresponding to the tens digit of the input number.

2. Stepping Switch Logic Circuits

The basic circuit used throughout the scanner to control the stepping switches is shown in Figure 3.

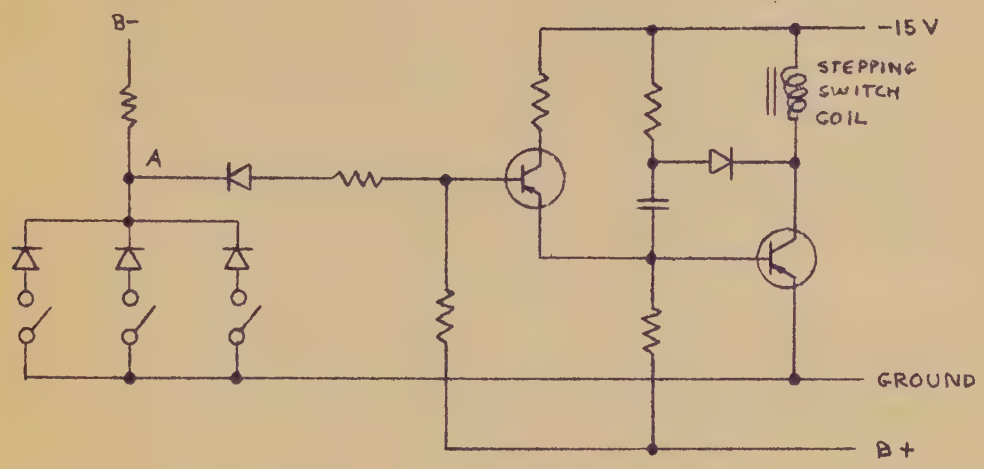



Figure 3.

If one or more of the switches shown in Figure 3 is closed, point A will be at (or near) ground potential. The transistors are cut off under these conditions. However, if all of the switches are open, point A becomes sufficiently negative to allow the transistors to conduct, energizing the stepping switch coil.

The switches shown in Figure 3 actually exist in several forms:

The collector of a transistor which is either cut off or saturated.

A readout lamp, which has very low resistance to ground when de-energized.

A contact of a stepping switch, which is grounded when the stepping switch is in certain positions.

Since the readout lamps are actually part of the logic circuits, improper operation of the scanner during resetting may take place if a readout lamp is burned out. Accordingly, operation of the scanner should not be attempted until any burned out lamps are replaced with G-E No. 330 bulbs or equivalent.

All diodes in the scanner which correspond to the diodes in series with the switches in Figure 3 are a high conductance type to insure minimum voltage drop.

3. Reset Circuitry (See Drawing No's 21028-020 Sheet 2B, 21028-030 Sheet 2, 21028-040 Sheet 2, and 11400-500 Sheet 2.)

A. As stated above, inputs 00 thru 59 are connected to K102 and inputs 60 thru 99 are connected to K103. K101 corresponds to the tens digit of the input number. Therefore, the following conditions must be satisfied during resetting:

Resetting to a number between 00 and 59 inclusive:

K101 must switch to the position corresponding to the tens digit of the selected number.
K102 must switch to the position corresponding to the units digit of the selected number.
K103 must switch to position zero, so that in operation if the scanner switches from 59 to 60, K103 will be in the right place for input number 60.

Resetting to a number 60 or above:

K101 must switch to the position corresponding to the tens digit of the input number.
K102 will not be used, and therefore is not reset in order to save time.
K103 must switch to the position corresponding to the units digit of the input number.

B. In the following circuit descriptions, component designations numbered in the 100's are on the main board (Drawing 21028-020 Sheet 2B), those numbered in the 200's are on the A Board (Drawing 21028-030 Sheet 2), and those numbered in the 300's are on the B Board (Drawing 21028-040 Sheet 2). The stepping switch drive circuitry shown in Figure 3 is located on the D Board. (Drawing 11400-500 Sheet 2.)

C. Reset pulses are generated by a free-running multivibrator consisting of Q208 and Q209. The pulses are connected to a bistable flip-flop consisting of Q210 and Q211, which serves as a frequency divider and pulse shaper. The resulting square wave, of about 30 cps, is available on the collector of Q211.

The pulses are gated by a flip-flop consisting of Q301 and Q302. Normally, Q302 is conducting, and its collector is at ground potential. (See Figure 4). The junction of R316 and CR304 is held at ground by the collector of Q302 via CR308 and CR303.

When the "Reset" switch is momentarily closed, Q301 and Q302 switch to the opposite state, so that the collector of Q302 is at B-. The junction of R316 and CR304 is now held at ground by the collector of Q211 via CR308 and CR217 between pulses, but during pulses, the drive circuit for K101 is energized, so that K101 steps in accordence with the pulses on the collector of Q211.

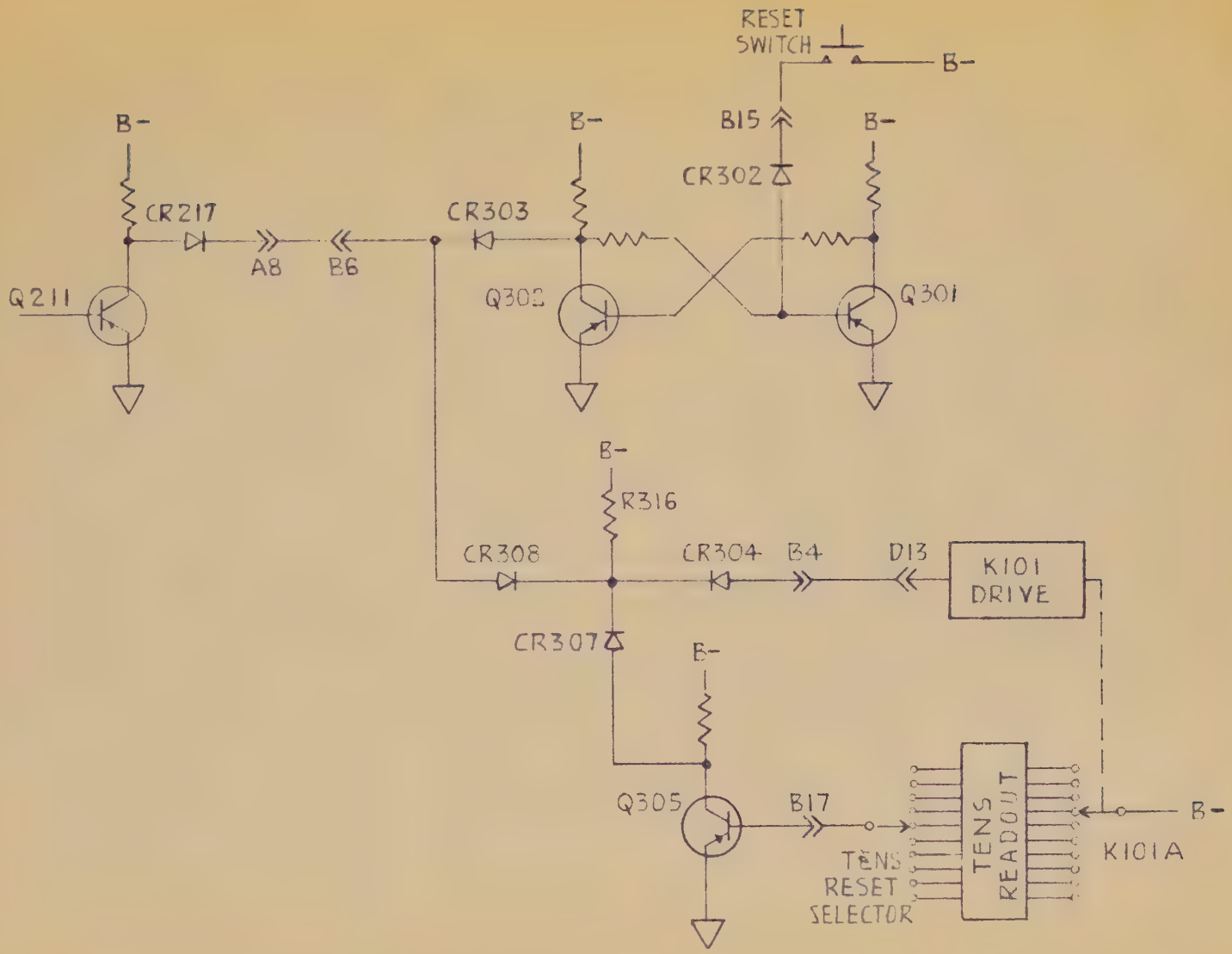

RESET
SWITCH
B-
B15
CR302
CR217
CR303
A8
B6
Q211
Q302
Q301
R316
CR308
CR304
B4
D13
K101
DRIVE
CR307
Q305
B17
TENS
RESET
SELECTOR
TENS
READOUT
K101A

FIGURE 4

When K101 reaches the position corresponding to the reset selector switch setting, B- is connected to the appropriate readout lamp, and to the input of Q305. This transistor conducts, its collector is now at ground potential, the junction of R316 and CR304 is therefore grounded via CR20, and K101 stops.

D. Transistors Q307 and Q308 control the selection of K102 or K103 for the remainder of the resetting period, as shown on Figure 5. If K101 is in position 0 thru 5, Q308 conducts, grounding the junction of R335 and CR325 via CR323, so that K103 can not be energized. Similarly, if K101 is in position 6 thru 9, Q307 conducts, grounding the junction of R323 and CR306 via CR312 so that K102 can not be energized. Therefore, either K102 or K103 can be energized by succeeding pulses, depending on the setting of K101.

If K101 is set to position 0 thru 5, K102 is pulsed until it reaches the position to which the units "Reset" selector switch is set, as shown in Figure 6.

The junction of R323 and CR306 is grounded via CR311, CR305, the tens "Reset" selector switch, and the un-lighted tens readout lamps until K101 has reset, at which time B- is connected to CR305. K102 then steps until it reaches the position corresponding to the setting of the units reset selector; Q306 is now energized via the and/or circuit. (See 3. E. below) The junction of R323 and CR306 is now grounded via CR311 and CR309, and K102 stops.

E. The and/or circuit, consisting of diodes CR331 thru CR338, in conjunction with diodes CR110 thru CR149 controls the positioning of K102. (See Figure 7). If K101 is in position 0,2, or 4, K102 must be set to one of the first tens positions; if K101 is in position 1, 3, or 5, K102 must be set to one of the second ten positions.

Point "A" of Figure 7 may be held near ground potential by CR331. & R341, CR332 & R342, and CR334 and the units readout lamps. Similar paths to ground exist for point "B". Q306 can be energized via CR333 or CR335 if point A or point B changes to B- potential. Point "A" will be at B- potential if K101 is in position 1, 3, or 5 (via CR331) and if K102 is in position 10 thru 19 (via CR332 and CR140 thru CR149) and if the number to which the units reset selector switch is set is energized (via CR334 and CR120 thru CR129). Point "B" may be energized in a similar manner.

Q306 therefore, will be energized when one of the above sets of conditions is satisfied, and resetting of K102 stops as described in 3. D. above.

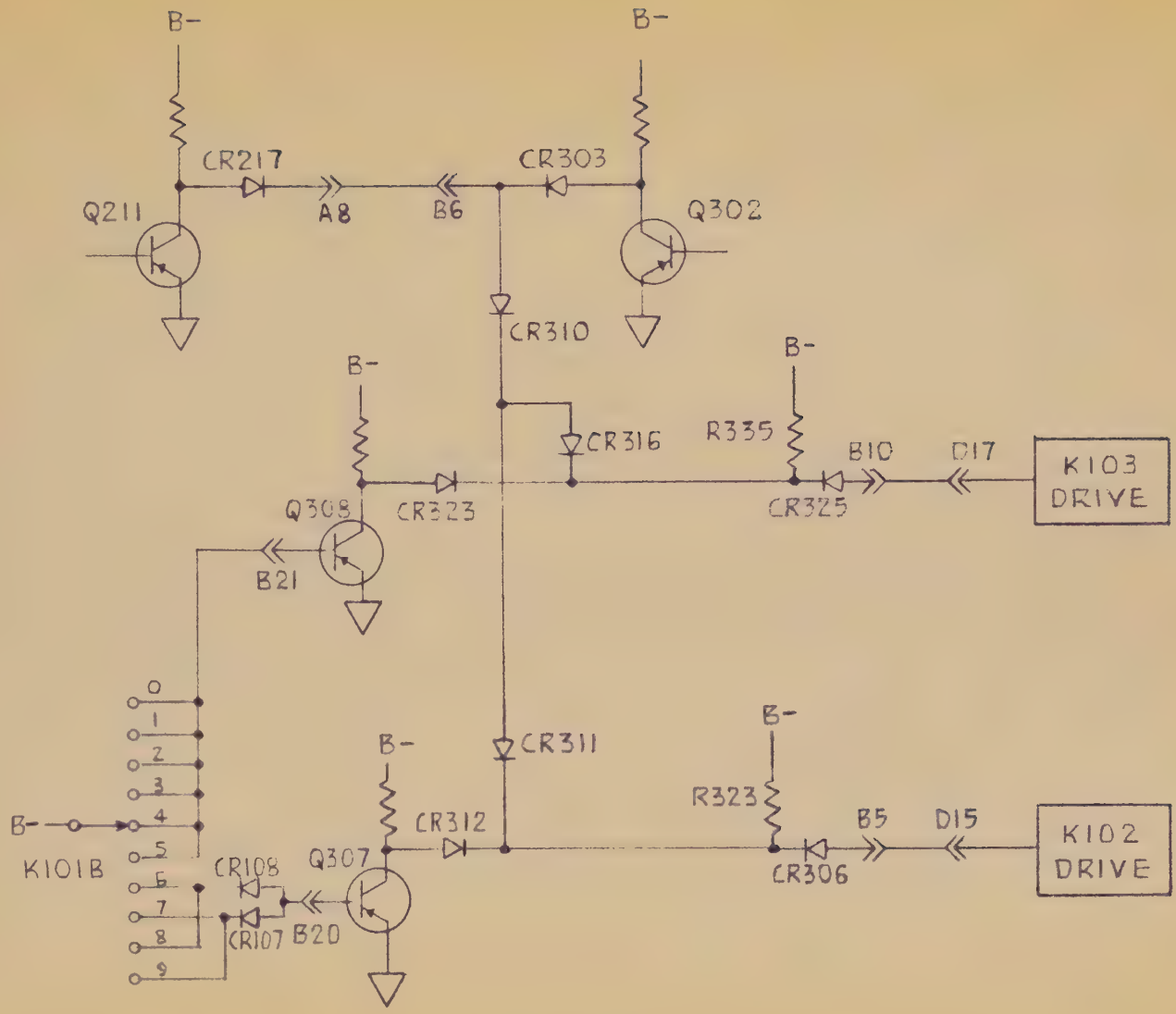

B-
B-
CR217
CR303
Q211
A8
B6
Q302
CR310
B-
B-
R335
CR316
B10
D17
K103
DRIVE
Q308
CR323
CR325
B21
0
1
2
3
4
5
6
7
8
9
B-
K101B
B-
CR311
B-
R323
CR312
B5
D15
K102
DRIVE
CR108
Q307
CR306
CR107
B20

FIGURE 5

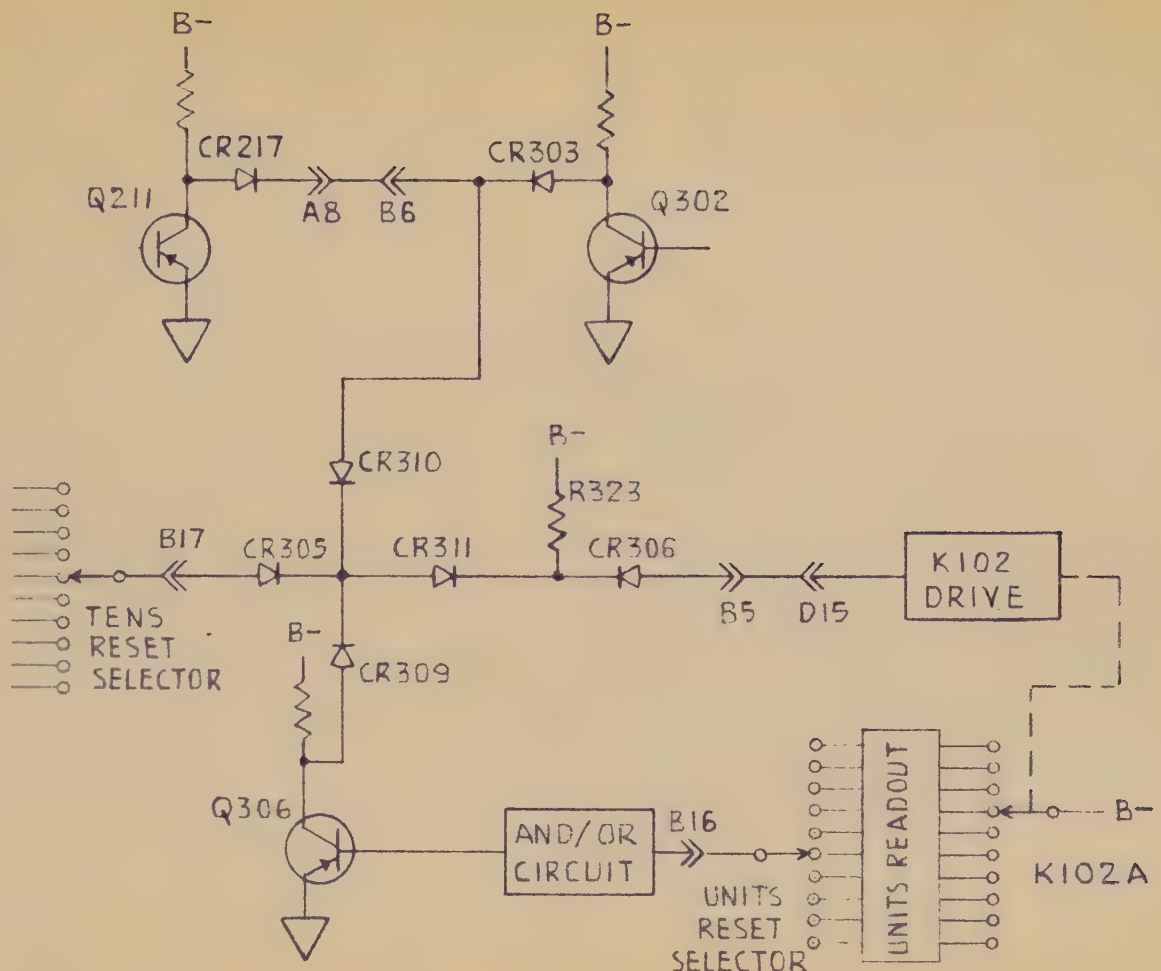

B-
B-
CR217
CR303
Q211
Q302
A8
B6
CR310
B-
R323
B17
CR305
CR311
CR306
K102
DRIVE
B5
D15
TENS
RESET
SELECTOR
B-
CR309
Q306
AND/OR
CIRCUIT
B16
UNITS READOUT
B-
K102A
UNITS
RESET
SELECTOR

FIGURE 6

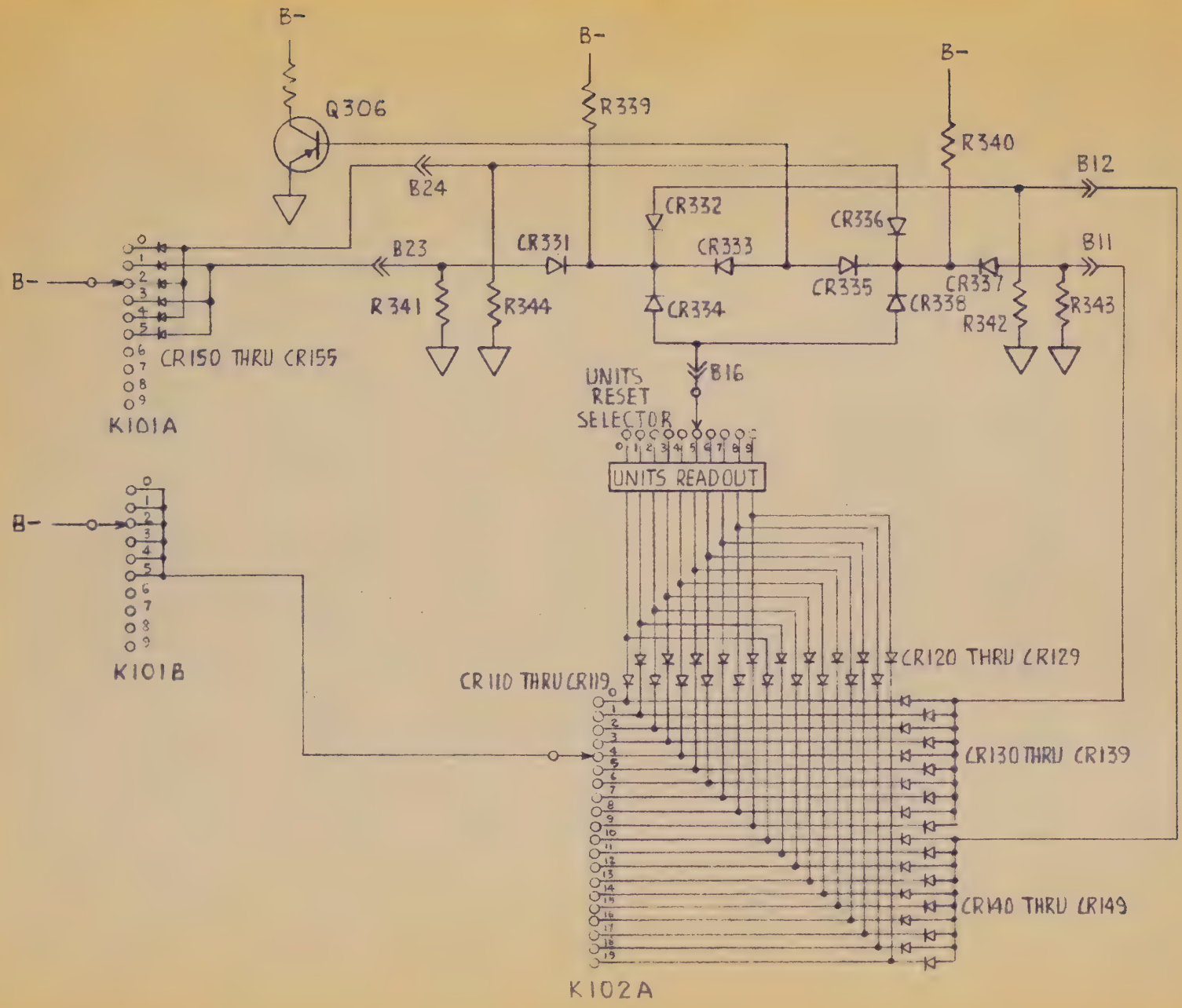

B-
Q306
R339
R340
B12
B24
CR332
CR336
B23
CR331
CR333
B11
B-
CR335
CR337
CR338
R341
R344
CR334
R342
R343
CR150 THRU CR155
K101A
B16
UNITS
RESET
SELECTOR
UNITS READOUT
B-
K101B
CR120 THRU CR129
CR110 THRU CR119
CR130 THRU CR139
CR140 THRU CR149
K102A

FIGURE 7

F. If K101 has been set to positions 0 thru 5, K103 must be set to position 0, so that if the scanner during operation switches from input 59 to 60, K103 will have been correctly positioned. This is done as shown in Figure 8.

The junction of R337 and CR327 is grounded via CR330, the tens "Reset" selector switch, and the unlighted tens readout lamps until K101 has reset, at which time B- is connected to CR330. K103 then steps until it reaches the zero position; the junction of R337 and CR327 is now grounded via CR318, and K103 stops. This portion of the resetting period takes place simultaneously with resetting K102 as explained above in 3. D.

G. If K101 is set to position 6 thru 9, instead of position 0 thru 5 as in 3. D, 3. E, and 3. F above, K103 is pulsed until it reaches the position to which the units "Reset" selector switch is set, as shown in Figure 9.

The junction of R335 and CR325 is grounded via CR316, CR305, the tens "Reset" selector switch, and the un-lighted readout lamps until K101 has reset, at which time B- is connected to CR305. K103 then steps until it reaches the position corresponding to the setting of the units "Reset" selector; Q306 is now energized via the and/or circuit. (See 3. H. below). The junction of R335 and CR325 is now grounded via CR316 and CR309, and K103 stops.

K103 is prevented from being driven to the zero position as described above in 3. F. by Q307 via CR322. Q307 is energized as shown in Figure 5.

H. The and/or circuit described above in 3. E. is still used to energize Q306, although most of its capabilities are not required since two levels of K103 are used to differentiate between the first and second ten positions; rather than one level as with K102. Accordingly, four inputs to the and/or circuit are directly energized by K101 via diodes CR109, CR156, CR157, and CR158 as shown in Figure 10.

I. When all of the conditions outlined in 3. A. above are satisfied, the reset pulse gate, consisting of Q301 and Q302 (See 3. C. above) must be closed. (See Figure 11). The junction of CR313, CR314, and CR315 is at B- potential if the opposite ends of one or more of these diodes is at B-. When K101 is reset, Q305 conducts. (See 3. C, Figure 4). When K102 or K103 is reset, Q306 conducts. (3. D. and Figure 6, or 3. G. and Figure 9). If K101 is set to position 0 thru 5, when K103 reaches position zero the junction of R334 and CR315 is grounded via CR317; if K101 is set to position 6 thru 9, Q307 is energized (See Figure 9), grounding the junction of R334 and CR315 via CR321.

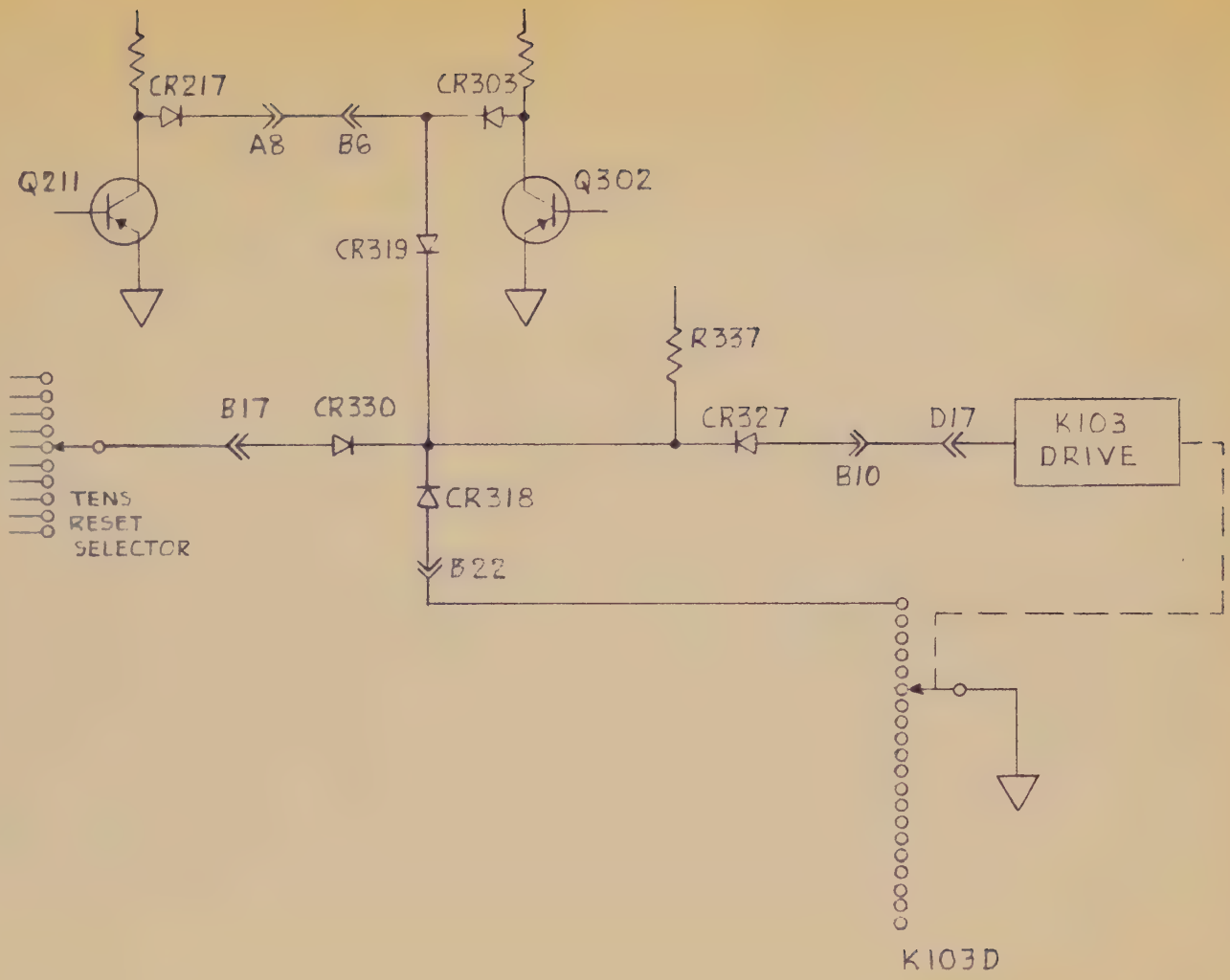

CR217
CR303
A8
B6
Q211
Q302
CR319
R337
B17
CR330
CR327
D17
K103
DRIVE
B10
TENS
RESET
SELECTOR
CR318
B22
K103D

FIGURE 8

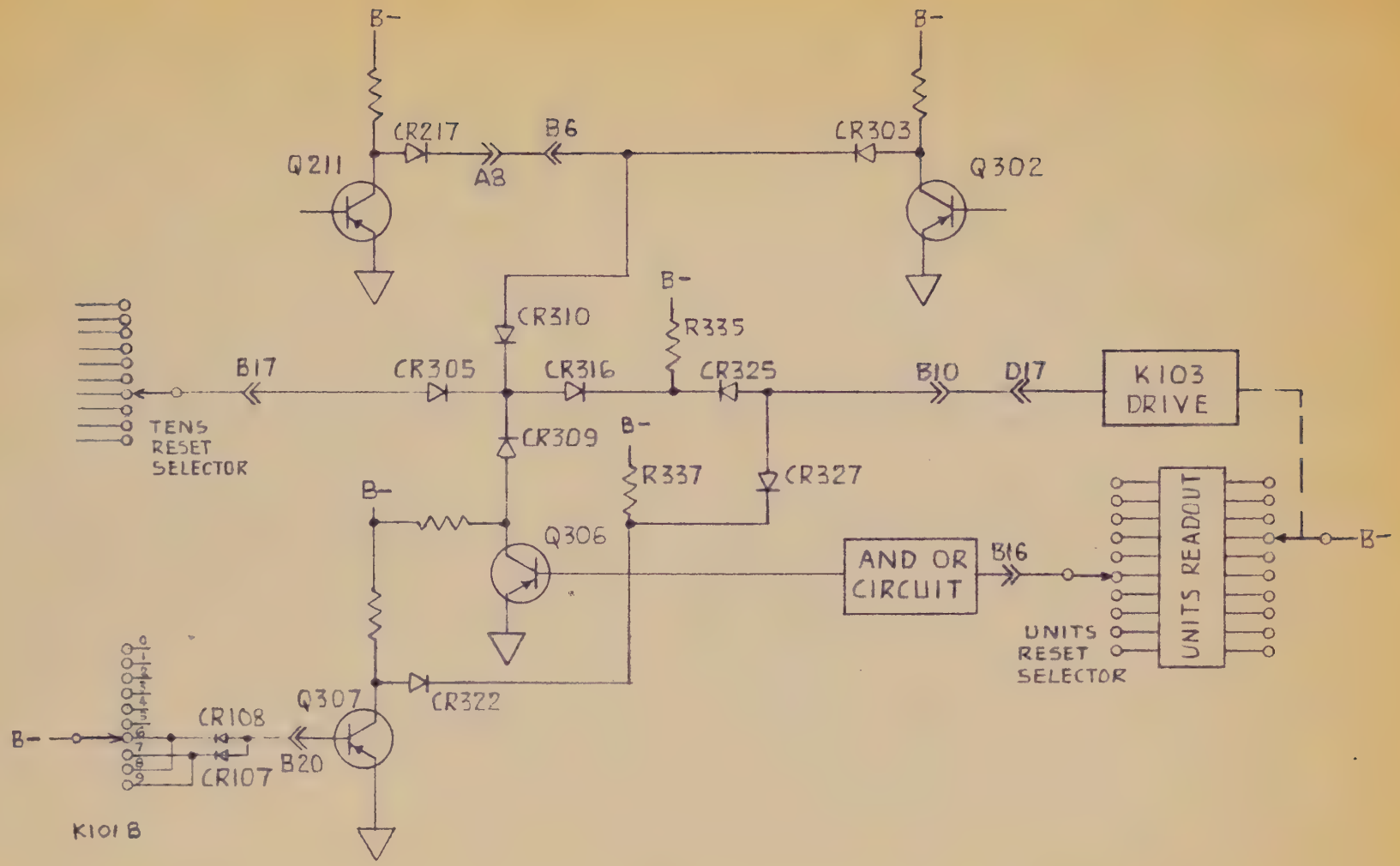

B-
B-
CR217
B6
A8
CR303
Q211
Q302
B-
CR310
R335
B17
CR305
CR316
CR325
B10
D17
K103
DRIVE
TENS
RESET
SELECTOR
CR309
B-
R337
CR327
B-
Q306
AND OR
CIRCUIT
B16
UNITS READOUT
B-
UNITS
RESET
SELECTOR
Q307
CR322
CR108
B-
B20
CR107
K101B

FIGURE 9

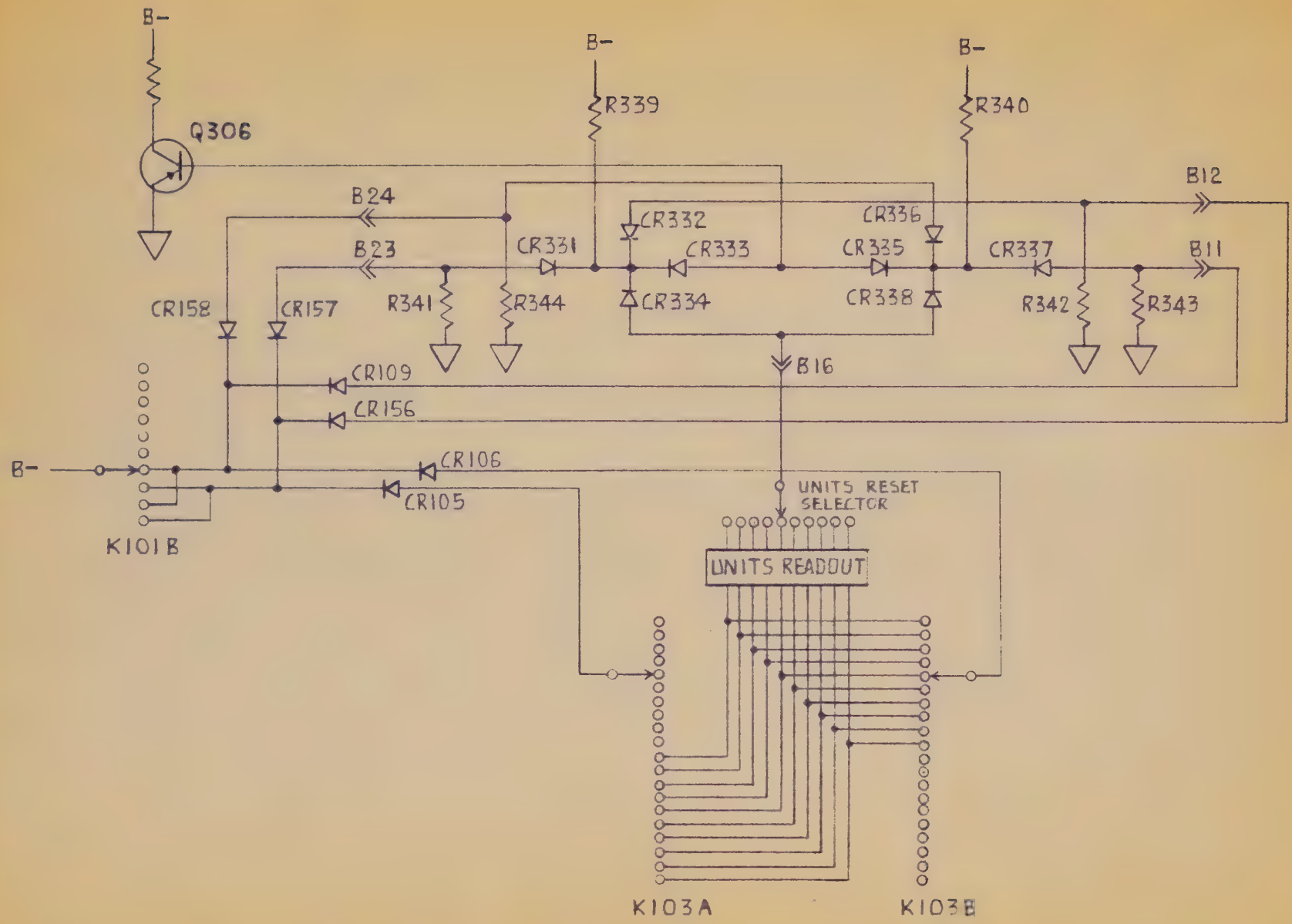

B-
B-
B-
R339
R340
Q306
B12
B24
CR332
CR336
B23
CR331
CR333
CR335
CR337
B11
CR158
CR157
R341
R344
CR334
CR338
R342
R343
B16
CR109
CR156
B-
CR106
CR105
UNITS RESET SELECTOR
UNITS READOUT
K101B
K103A
K103B

FIGURE 10

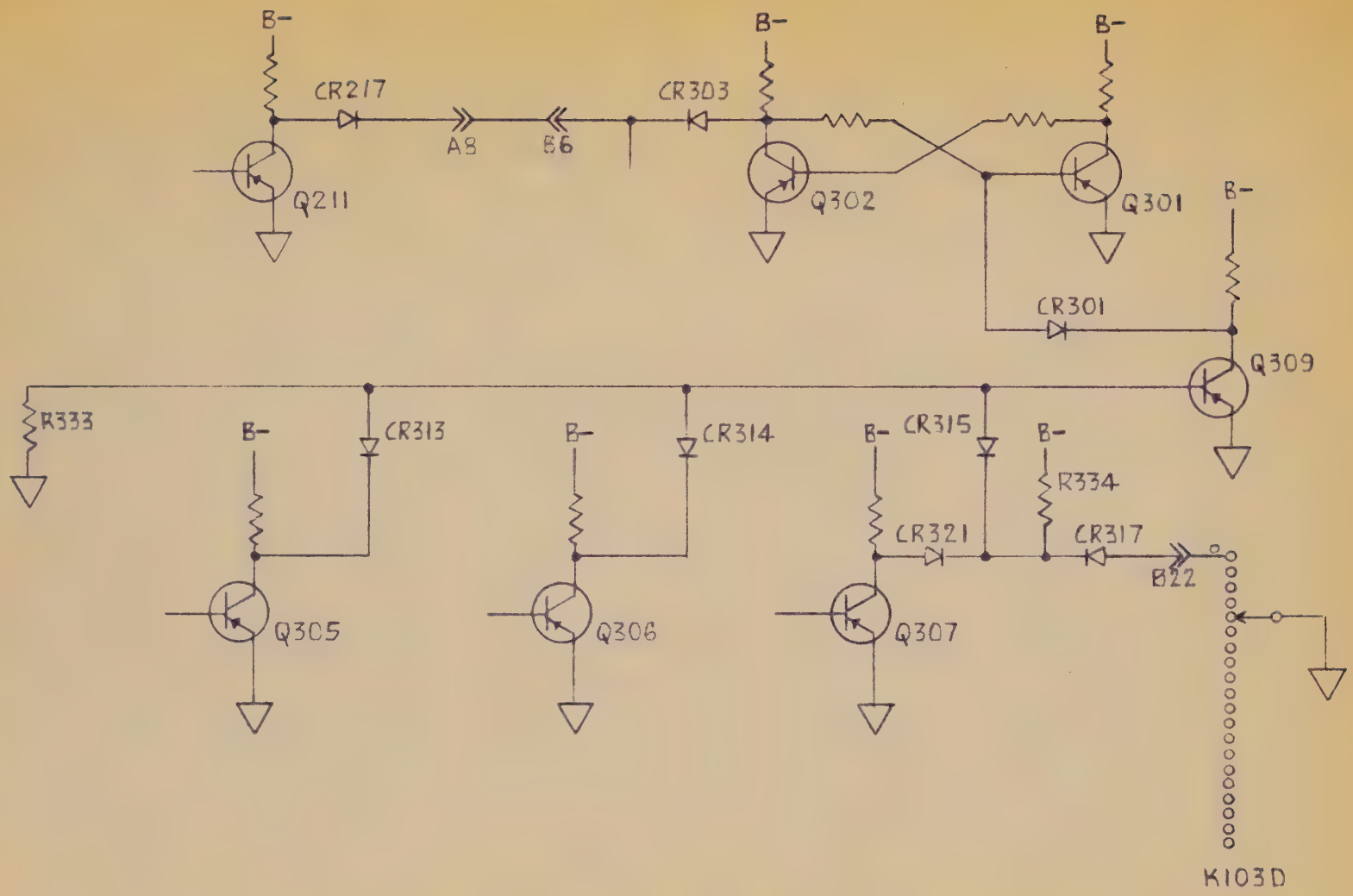

B-
CR217
A8
B6
CR303
Q211
Q302
Q301
CR301
Q309
R333
CR313
CR314
CR315
R334
CR321
CR317
B22
Q305
Q306
Q307
K103D

FIGURE 11

Therefore, when CR313, CR314, and CR315 are all grounded, Q309 is cut off, switching Q301 and Q302 to the opposite state so that the collector of Q302 is at ground, thereby preventing any further reset pulses from reaching the stepping switches until the "Reset" switch is again actuated as in 3. C. above.

4. Start and Advance Circuitry

A. Advance pulses are generated by a one-shot multivibrator consisting of Q202 and Q203. (See Figure 12). This circuit is triggered by the switch contacts in the printer at the completion of data recording. The pulses are connected to a buffer consisting of Q201, which prevents variations in load from affecting the multivibrator. The resulting pulses are available on the collector of Q201.

The pulses are gated by a flip-flop consisting of Q204 and Q205. When the scanner is not operating, the collector of Q205 is at ground potential.

B. When the "Start" switch is momentarily closed, Q204 and Q205 are switched to the opposite state via CR207. Also, relay K104 is momentarily energized via CR211 and Q206. The resulting contact transfer causes the digital voltmeter to measure the first input and trigger the printer. When the printer has recorded the data, switch contacts in the printer trigger Q202 and Q203, and a pulse appears on the collector of Q201. This pulse is routed to the stepping switch drive circuits via CR202 and CR204 as shown in Figure 13.

C. Transistors Q307 and Q308 control the selection of K102 or K103. If K101 is in position 0 thru 5, Q308 conducts, grounding the junction of R336 and CR326 via CR324, so that K103 can not be energized. Similarly, if K101 is in position 6 thru 9, Q307 conducts, grounding the junction of R243 and CR222 via CR223 so that K102 can not be energized. Therefore, depending on the setting of K101, either K102 or K103 is stepped one position by the pulse from CR204 via CR221 or CR320. Relay K104 is also energized by the same pulse, via CR210 and Q206; The cycle outlined in 4. B. above is therefore repeated.

D. K101 is prevented from being energized by the pulse from CR204 because the junction of R241 and CR220 is grounded via CR219 and the un-lighted "9" lamp in the units readout. However, when the units digit is a nine, K101 must be energized simultaneously with K102 or K103 (when switching from 19 to 20, 29 to 30 etc.). Therefore, when K102 or K103 is in position 9 or 19, CR219 is at B- potential, and K101 is energized by the pulse from CR204 via CR218.

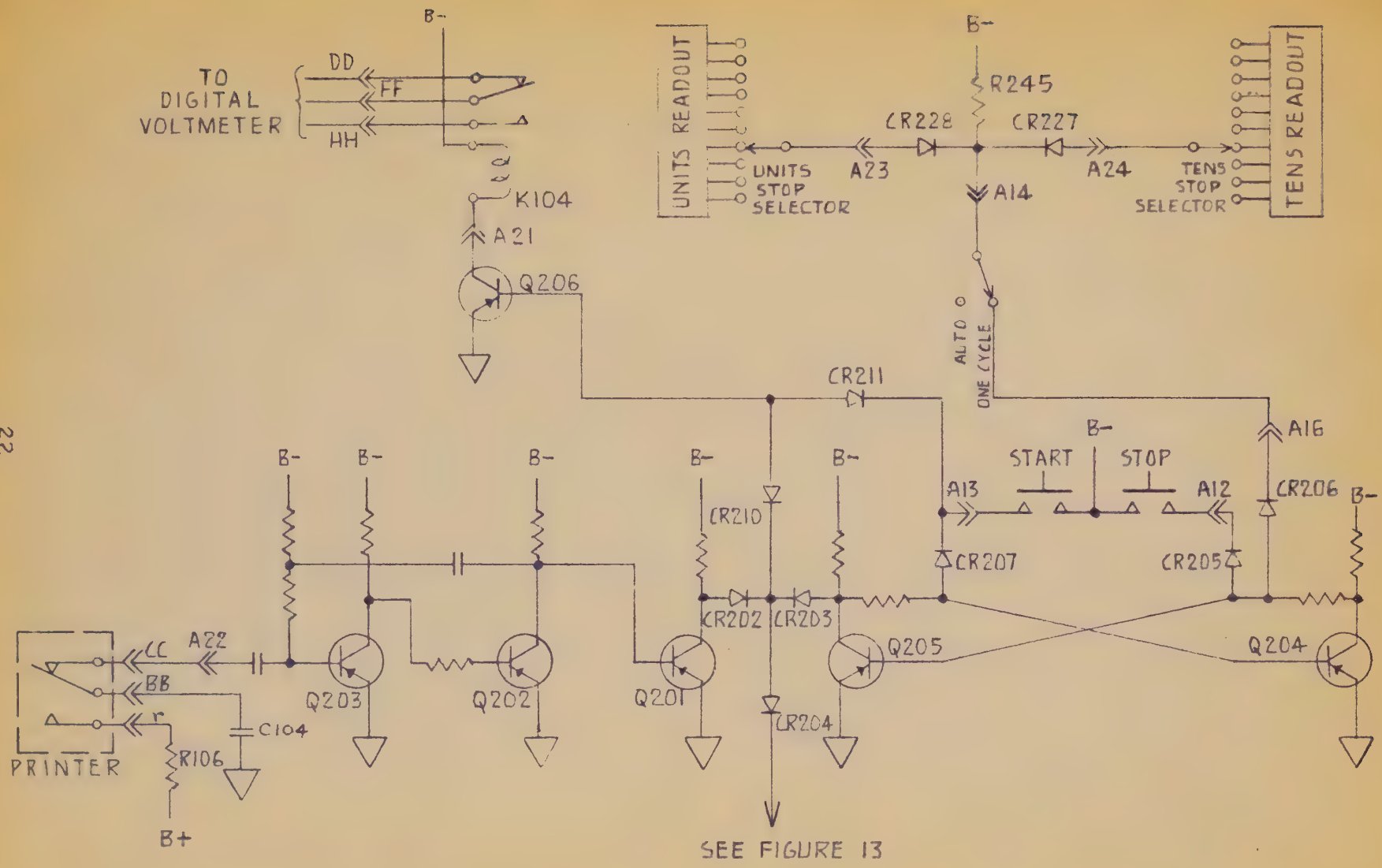

B-
TO DIGITAL VOLTMETER
DD
FF
HH
K104
A21
Q206
UNITS READOUT
UNITS STOP SELECTOR
A23
CR228
R245
CR227
A24
TENS STOP SELECTOR
TENS READOUT
A14
ALTO ONE CYCLE
CR211
A16
START
STOP
A13
A12
CR206
CR210
CR207
CR205
CR202
CR203
Q205
Q204
Q203
Q202
Q201
CR204
A22
CC
BB
r
C104
R106
PRINTER
B+
SEE FIGURE 13

FIGURE 12

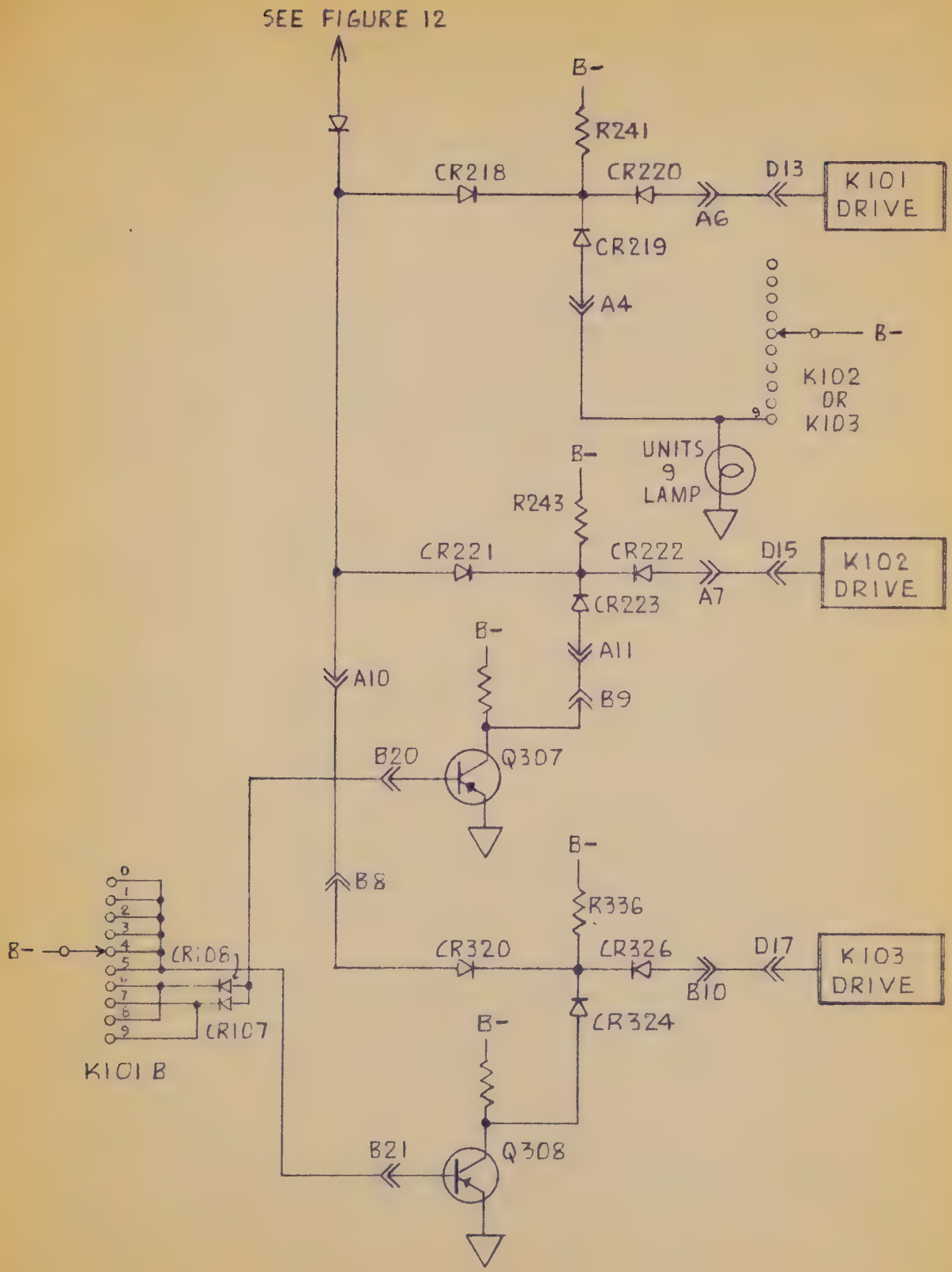

SEE FIGURE 12
B-
R241
CR218
CR220
D13
K101 DRIVE
A6
CR219
A4
B-
K102 OR K103
9
UNITS 9 LAMP
B-
R243
CR221
CR222
D15
K102 DRIVE
A7
CR223
A11
B9
A10
B-
B20
Q307
B-
R336
B8
CR320
CR326
D17
K103 DRIVE
B10
CR324
B-
B21
Q308
B-
0
1
2
3
4
5
6
7
8
9
CR106
CR107
K101 B

FIGURE 13

E. If the power switch is in the "One Cycle" position, operation must stop when the scanner switches to the position corresponding to the setting of the "Stop" selector switches. (See Figure 12.) The junction of R245, CR227 and CR228 is normally at ground potential; when K101 reaches the position corresponding to the setting of the tens "Stop" selector, B- appears at CR227. Similarly, when K102 or K103 reaches the selected position, B- appears at CR228, at which time the junction of CR227 and CR228 changes to B- potential, and Q204 and Q205 are switched to the opposite state via CR206.

F. If the power switch is in the "Auto Cycle" position, operation is as shown in Figure 14. When the junction of CR227 and CR228 reaches B- potential, as explained in 4. F. above, Q207 is energized. The junction of CR202, CR203 and CR204 is therefore grounded via CR214, so that the next pulse from Q201 is not routed to the stepping switches as in Figure 13.

The junction of CR225, CR224 and R244 is normally held at ground potential via CR225 and CR224. However, when the junction of CR227 and CR228 reaches B- potential, and when a pulse occurs on the collector of Q201, the resultant pulse at the junction of CR225, CR224 and R244 is routed via CR226 to the flip-flop consisting of Q301 and Q302, and resetting starts as in 3. C. above.

As soon as the stepping switches start to move, the junction of CR228 and CR227 will return to ground potential, cutting off Q207. Since this may happen before the pulse from Q201 is terminated, CR208 is connected between the collector of Q301, which is grounded during resetting, and the junction of CR202, CR203, and CR204; in this manner, the stepping switches are prevented from being energized via the paths shown in Figure 13.

G. When resetting stops, as explained above in 3. I., the collector of Q302 changes from B- to ground potential. The resulting positive-going pulse triggers the one-shot multivibrator consisting of Q303 and Q304. A pulse is produced on the collector of Q304, which is routed via CR209 to Q306, momentarily energizing relay K104 and starting the cycle as in 4. B. above.

## 5. Component Locations

Locations of components on the "A" and "B" plug-in boards, and of diodes CR105 thru CR158 on the main board, are shown in Figures 15, 16, and 17 respectively.

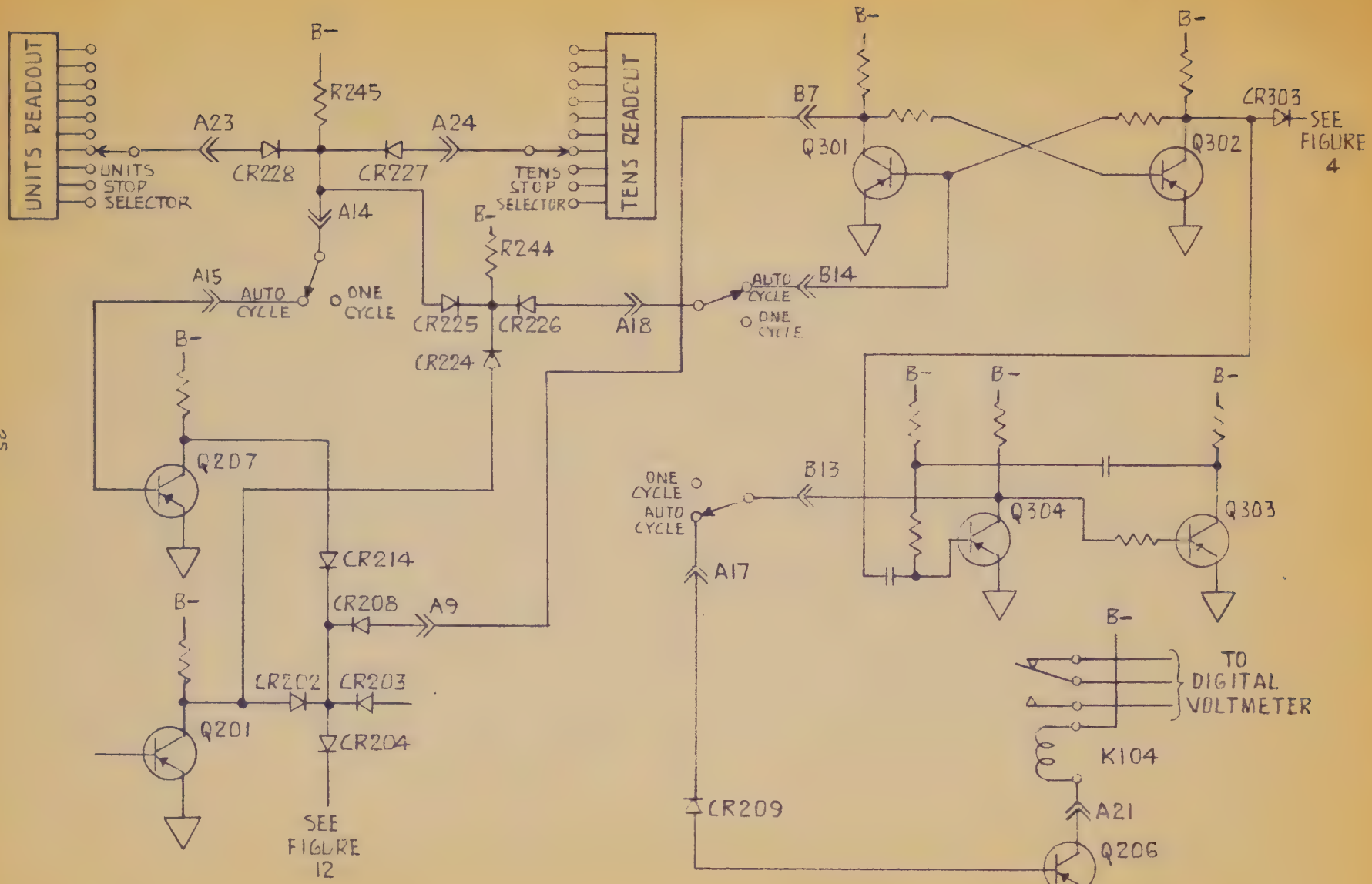
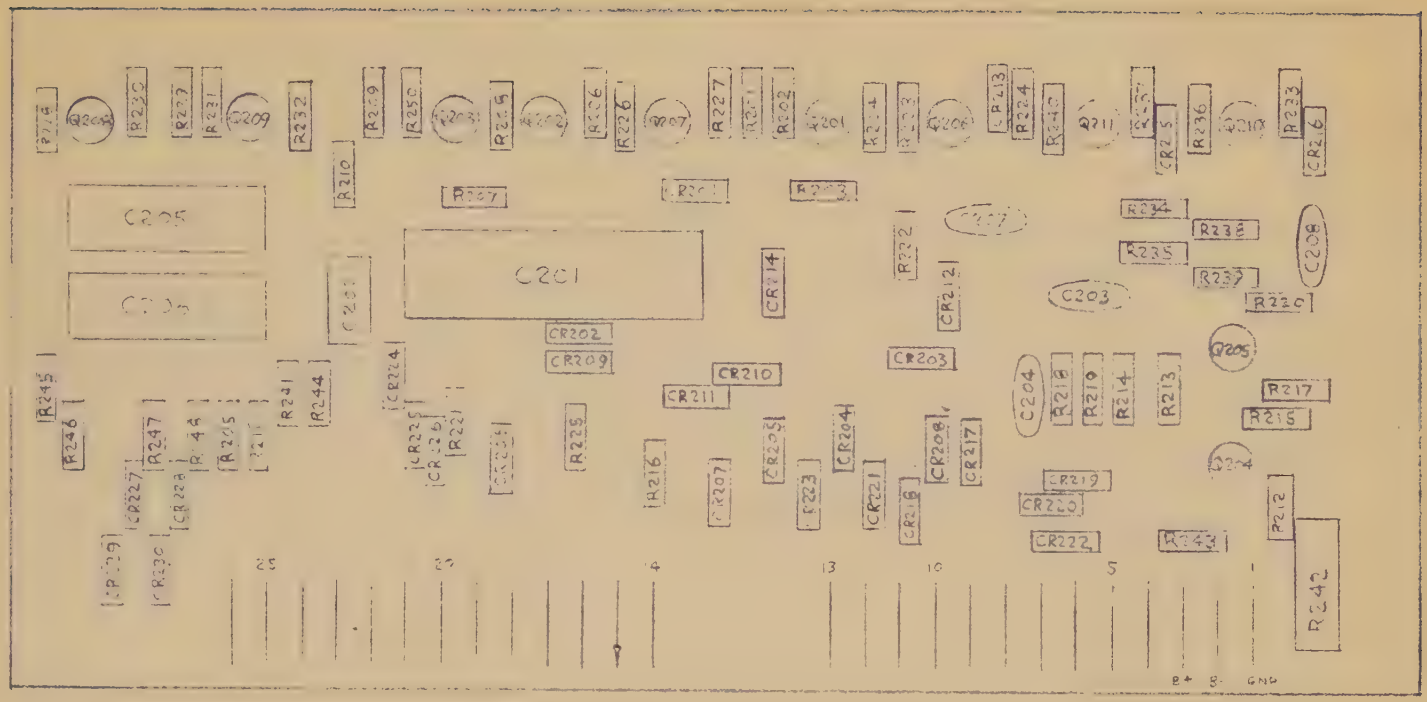

UNITS READOUT
UNITS STOP SELECTOR
TENS STOP SELECTOR
TENS READOUT
B-
R245
A23
A24
CR228
CR227
A14
R244
A15
AUTO CYCLE
ONE CYCLE
CR225
CR226
CR224
A18
B7
B14
Q301
Q302
CR303
SEE FIGURE 4
Q207
CR214
CR208
A9
Q201
CR202
CR203
CR204
SEE FIGURE 12
B13
A17
Q304
Q303
TO DIGITAL VOLTMETER
K104
A21
CR209
Q206

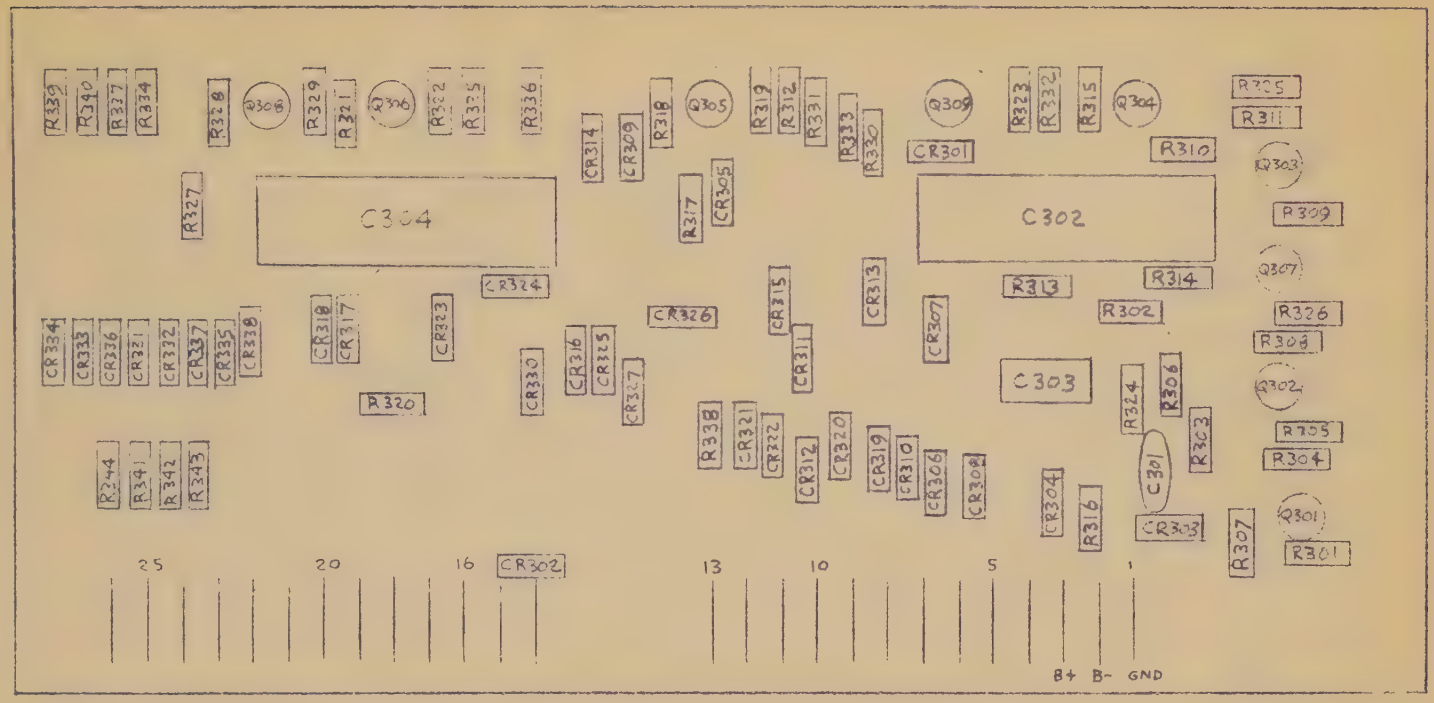
FIGURE 14




"A" BOARD

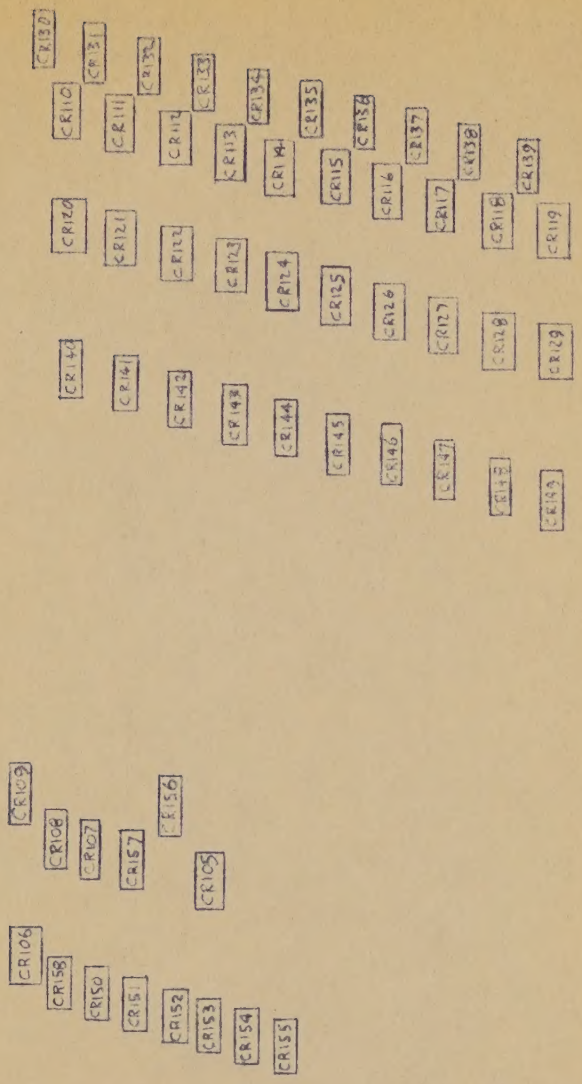
COMPONENT ARRANGEMENT

FIGURE 15




"B" BOARD
COMPONENT ARRANGEMENT

FIGURE 16




COMPONENT ARRANGEMENT

MAIN BOARD

(LOCATED UNDER STEPPING SWITCHES)

FIGURE 17

525

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